Warm but dull month for December 2021

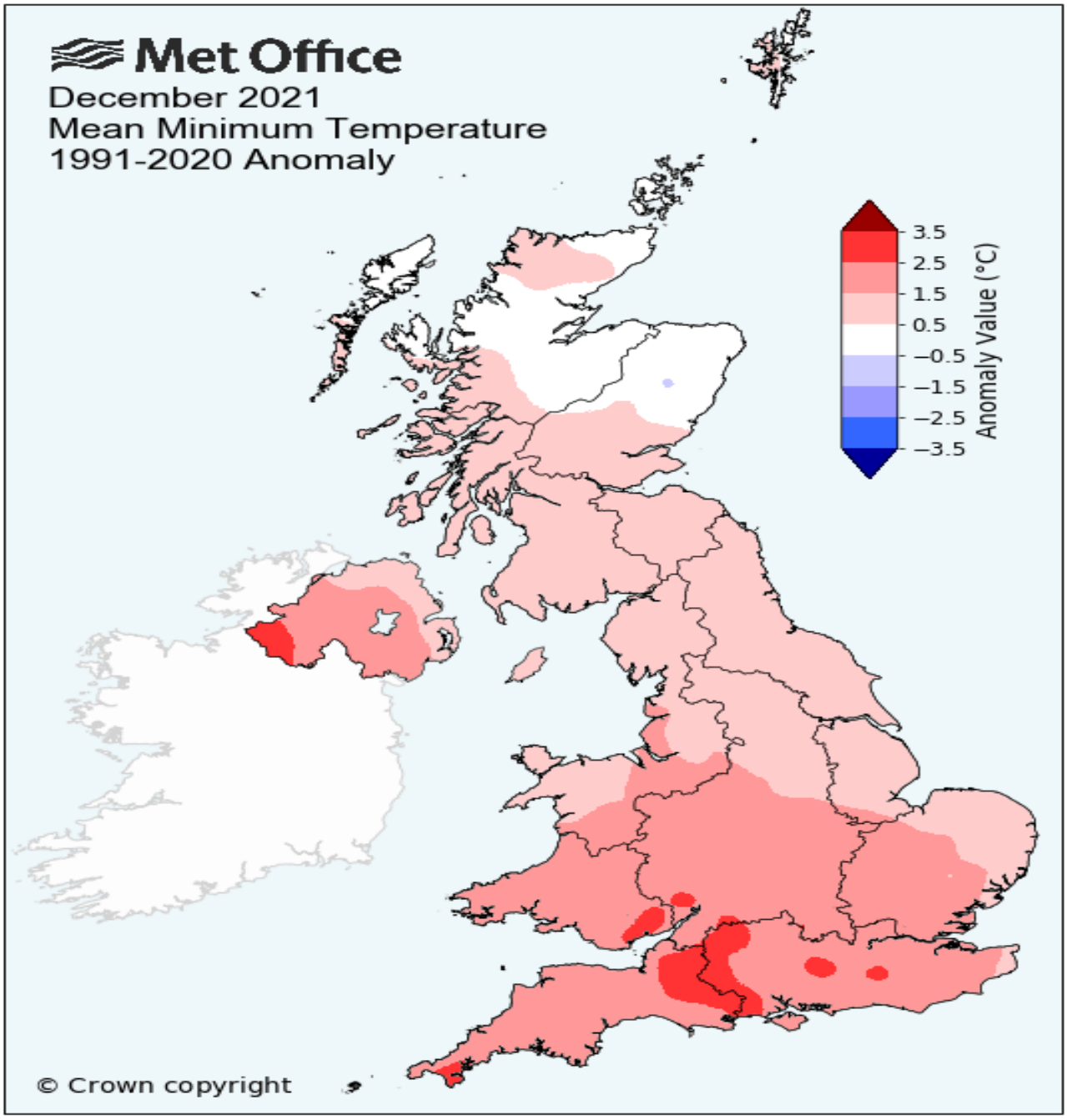
Description

December 2021 kicked off meteorological winter with a broadly warm – albeit dull – month of weather, during which the UK reached its highest New Year's Eve temperature on record, with 16.5°C at Bala (north Wales). Maximum temperatures also exceeded 15°C in all four nations. This is according to provisional figures released by the Met Office.

The unusually high temperatures seen on New Year's Eve coincided with a temperate end to December, resulting in some stations breaking long-standing one-off records for the month. Cromer in Norfolk saw its warmest December day in a 103-year series with 15.4°C recorded on 30th December.

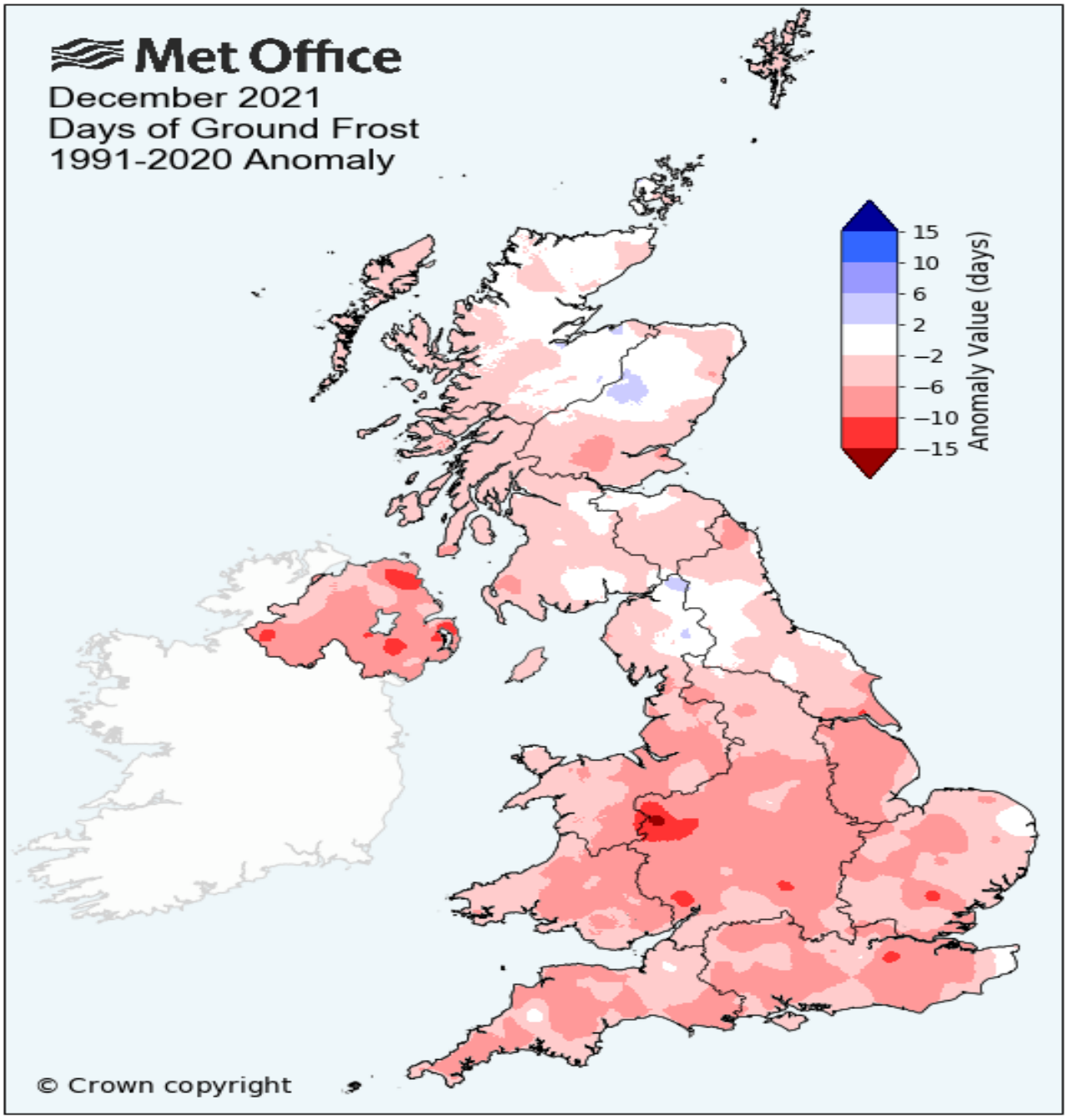
For the complete month, it's the notably high minimum temperatures recorded in December that stand out from the statistics, especially in southern areas. The UK had an average minimum temperature in December of 2.8°C, which is 1.4°C above the 1991-2020 long-term average; figures that have recently been updated to reflect the latest 30-year meteorological period. The highest average minimum temperature seen in December stands at 5.2°C, set in 2015.

For southern areas, minimum temperatures were even further from the meteorological averages, with southern England seeing average minimum temperatures at 4.3°C, which is 2.0°C above the long-term average for the month. There were some exceptionally mild nights, with overcast conditions and a south-westerly flow drawing air from the Azores. Daily minimum temperatures on New Year's Eve remained widely in double figures, with several stations including Sheffield, Bradford and Buxton recording their highest daily minimum temperature on record in series of over 100 years – around 10°C higher than the December average.



Average minimum temperatures versus the long term average for December 2021

The often mild, cloudy nights resulted in below average days of frost for the much of the UK. There was an average of just 11.5 days of ground frost reported across the UK in December, well below the long-term average of 16.3 days. The fewest average number of days of ground frost in December was in 2015, with just 5.8 days.

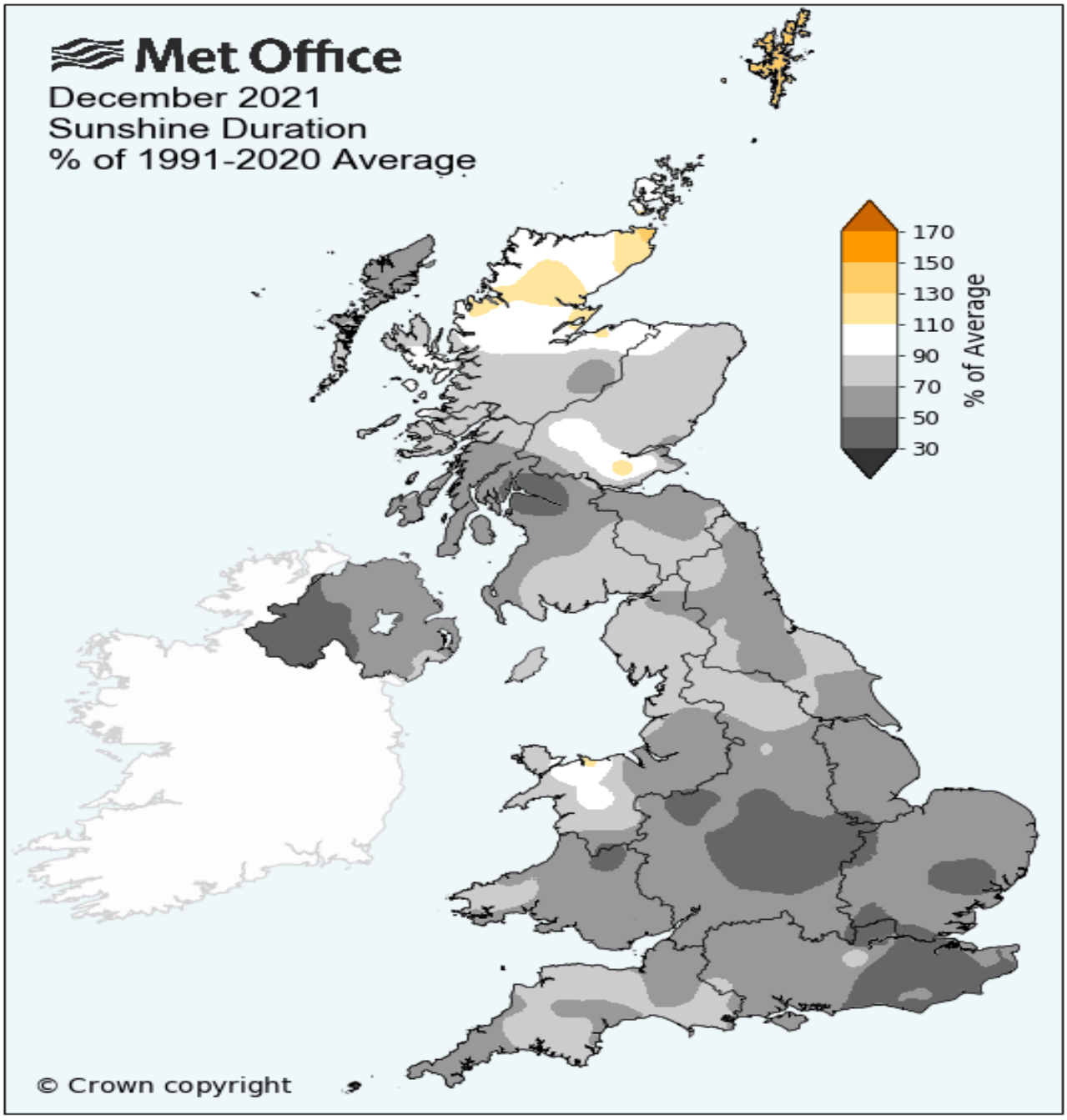


Average number of ground frost days in the UK in December 2021 versus the long term average

Despite the relatively high temperatures, sunshine hours in December 2021 have been in short supply, with an average of just 27.6 hours for the UK, less than one hour per day on average and only around two-thirds of the normal December sunshine total. That's little enough to make it the dullest December since 1956, when an average of 19.5 hours of sunshine was seen. It was also the UK's sixth dullest calendar month in records from 1919. England saw 60% (30.6 hours) of its average sunshine, Wales 69% (28.3 hours), Scotland 79% (23.6 hours) and Northern Ireland only 54% (20.7 hours).

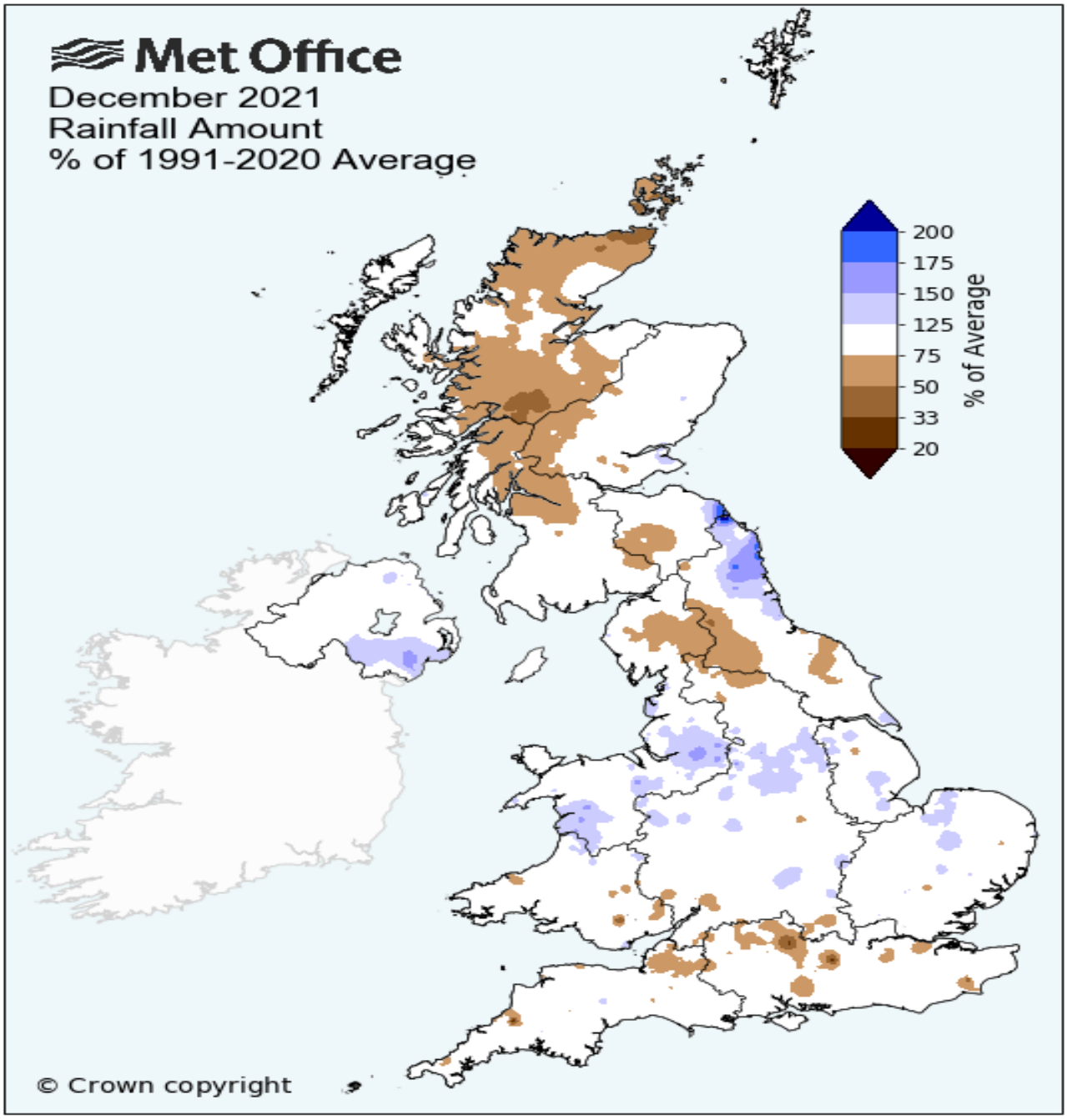
The dull but warm conditions have provided an unusual mix for the country's gardeners. Chief Horticultural Advisor at the Royal Horticultural Society Guy Barter said: "After milder weather and limited frosts so far this winter, greens such as Brussels sprouts and leeks have kept growing and winter flowers such as autumn flowering camellia and Christmas roses have not been spoilt.

"Weeds too have kept growing but with dull conditions they won't set seeds and can be spared for now to help wildlife. Lawns remain remarkably green but growth has been limited by a lack of light, so the lawnmower can rest a bit longer."



Sunshine duration for the UK versus the long term average for December

Rainfall was relatively near average for much of the UK, although areas in the northwest generally saw less than their average. Northern Ireland received 113% (136.6mm), whereas Scotland received 79% (136.8mm). The UK had 90% of its average rainfall (115.1mm).



Mike Kendon from the National Climate Information Centre said: “December will largely be remembered for the unseasonable warmth we saw in the middle and end of the month. As a result, we have seen relatively few days of ground frost and air frost and less of the cold weather that you’d normally expect at the start of winter, although some northern spots have seen some hard frosts. There were also remarkable temperature inversion conditions for several days in Scotland where the warmest and sunniest place to be was across the mountain summits.

“This spell of weather in the middle of the month was driven by an established area of high pressure over the UK, keeping temperatures well above average for spells, although low temperatures did take charge in the early part of December.”

December 2021 also saw a white Christmas declared by the Met Office, with a flurry of snow over high ground in the north of the UK.

Check the Met Office website for a full round-up of 2021’s year in weather.

Provisional December 2021	Mean temp (°C)		Sunshine (hours)		Rainfall (mm)	
	Actual	Diff from avg (°C)	Actual	% of avg	Actual	% of avg
UK	5.3	1.1	27.6	65	115.1	90
England	6.1	1.4	30.6	60	88.6	96
Wales	6.4	1.5	28.3	69	184.4	105
Scotland	3.4	0.4	23.6	79	136.8	79
N Ireland	6.1	1.4	20.7	54	136.6	113

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Shackleton and the Antarctic 100 years on

Description

To commemorate the hundredth anniversary of the death of Ernest Shackleton, the Met Office has produced a video paying tribute to the Polar explorer's incredible exploits and explaining why the Antarctic remains essential for scientists researching climate change.

Shackleton's last voyage

Antarctica: the world's southernmost, driest, highest, windiest, coldest, and least populated continent, twice the size of Australia. The coldest temperature ever recorded, -89.0°C, was recorded here. Even now, visiting and exploring this extreme location is fraught with danger, so imagine how hazardous it was to visit a hundred years ago.

For explorer Ernest Shackleton, who died at South Georgia *en-route* to Antarctica 100 years ago today (5 January), this icy wilderness was an enduring source of fascination.

"Shackleton was no newcomer to the Antarctic," says Met Office archivist Catherine Ross. "His first trip there was on the Discovery expedition with Sir Robert Falcon Scott, he then led his own expedition in 1907 when he reached the furthest South any man had reached.

Shackleton was voted 11th in a poll of the greatest Britons in 2002

“In 1914 he led another expedition which was seeking to cross the Antarctic from coast to coast via the South Pole. That expedition became more famous because the vessel, the Endurance, became trapped in the ice and was crushed. Shackleton then led an incredible voyage that included travelling 720 miles across the South Antarctic Seas in a lifeboat followed by traversing a frozen mountain range with no climbing equipment or map.”

Shackleton’s bravery – which won him eleventh place in a 2002 BBC poll of the greatest Britons – was driven by a sense of adventure. While many early expeditions to Antarctica were motivated by a desire for national or personal glory, today’s visitors are motivated by something else: scientific

understanding. For scientists such as those from the British Antarctic Survey (BAS), based at Halley Research Station, monitoring the region's climate and ice cover can help with forecasting future trends, including climate change.

Eight hours by plane from Halley Island lies Rothera, on Adelaide Island, which is partly-manned by a detachment of meteorologists from the Met Office. The team provides weather forecasts for aviation and in and out of the base, where temperatures rarely rise much above zero. The Met Office links to Antarctica can be traced right back to Shackleton.

Early expeditions to the Antarctic were hazardous

"The Met Office [then part of the Air Ministry], loaned Shackleton's expedition a range of meteorological observing instruments," says Ross, "so barometers, thermometers, and other pieces of equipment to enable them to run a meteorological observing station at sea, and they collected some two thousand sets of observations from the voyage."

These observations included temperature, sea temperature, pressure, wind direction and force, and hand-written observations on things like the state of the ice. As such, they have proved vital in understanding how climate has changed in the last century.

"The records from Shackleton's era are so important because they allow us to see whether the changes we are seeing now are unusual, particularly with the sea ice," says Met Office Climate Scientist Dr Helene Hewitt. "The Endurance was trapped in the sea ice of the Weddell Sea for ten months, and those observations have enabled scientists to see whether sea ice has changed dramatically in the last hundred years or so."

Antarctica is beautiful but hostile for visitors

If all the land-based ice in Antarctica was to melt, it is estimated the Earth's sea level would rise by 60-70m. Fortunately, that is unlikely in the near future – but all melting has an impact on sea levels. Unlike the Arctic, which is principally sea ice, Antarctica sits on solid rock. This means events like the recent destabilising of Thwaites Glacier could have a major impact on sea levels.

In Shackleton's era, weather and ice measurements were taken by hand and methodically recorded in logbooks, available within the Met Office digital archives. Now, ice cover is measured using more high-tech methods, including satellite.

Polar exploration and observation have changed massively since Shackleton's day – but if he were to meet the modern-day scientists now living and working at the bottom of the world, he might well recognise them as kindred spirits.

Watch the video tribute to Ernest Shackleton

Find out more about the British Antarctic Survey

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January 2022

Scientists call for research to rise to the challenge of HILL events

Description

The higher global temperatures rise, the greater the likelihood of extreme weather events

Extreme weather events have become more frequent in recent years, and many of these can be attributed to climate change. The capabilities of weather forecasting and longer-term climate modelling have improved exponentially over recent decades, but even the best forecasting tools are challenged by “High Impact, Low Likelihood” (HILL) events.

HILL events go beyond traditional weather extremes, potentially taking the climate system into uncharted territories. For example, much of the UK’s climate is predicated on two large elements of the climate system: the North Atlantic jet stream, a core of strong winds five to seven miles above the Earth’s surface, and the Atlantic Meridional Overturning Circulation (AMOC), a system of ocean currents which transports warm water northwards in the Atlantic.

Changes in both of these systems linked to increasing warmth in the Arctic have been cited as potential HILL events. A change in either or both isn’t considered likely in the immediate future (low likelihood), but the impacts from such changes would be devastating (high impact). One example of an unusual weather event is extreme rainfall.

In July 2021, parts of London received up to a month’s rainfall in an hour, causing flash flooding and

disrupting transport. This event – which went on to cause devastating flooding and loss of life in continental Europe – was created when an area of slow-moving low pressure became trapped in the meridian of the Jet Stream, creating what's known as a "Quasi-stationary" storm.

Professor Lizzie Kendon, Science Fellow at the Met Office, published a paper with Dr Abdullah Kahraman, of Newcastle University, in 2021 which found that "quasi-stationary" storms that exceed specific thresholds in moisture and uplift, where they are pushed up by rising terrain (and so have the potential for high rainfall accumulations) could become 14 times more common across Europe as a whole by the end of the century.

Further analysis for the UK, using the latest UKCP Local (2.2km) projections indicate that the number of days with rainfall exceeding 30mm/h (for at least one 5km grid box across London) could – using the most pessimistic scenario of action to tackle climate change increase 2.5 times by the 2070s compared to 1990s under the RCP8.5 scenario. These results suggest a big increase in the frequency of flash-flood producing rainfall events.

HILL events were a key theme of the Met Office Climate Science Conference in May 2021, and the Met Office also hosted a session on HILL events at the COP26 Science Pavilion.

Met Office Science Strategic Head Dr Richard Wood said: "Both the climate science and policy communities would benefit from devoting more attention to HILL events because they are a major component of climate change risk. There are some key questions that need answering as we move towards implementing a desired pathway for the global climate and living with the consequences. Although it isn't certain where the thresholds are for these HILL events, we can be sure that higher levels of global warming will make them more likely."

Prof Richard Betts MBE is the Head of Climate Impacts Research in the Met Office Hadley Centre and a Professor at the University of Exeter. Prof Betts, who led the team which prepared the Technical Report for the UK's 3rd Climate Change Risk Assessment (CCRA3), is calling for a monitoring, attribution and prediction system that can provide early warning of HILLs.

Professor Betts said: "With rising global temperatures, we are edging closer to the thresholds for more and more HILL events. Greater research into these events will help scientists advise policy makers on their thresholds and impacts."

Risk registers could form an essential part of the future planning of all key sectors of the economy, such as finance and energy, to mitigate against HILL events. The better adapted we are, the more lives can be protected. There will be financial benefits too. For instance, by assessing potential flood risk as a result of climate change, science can help developers avoid building on flood plains, save money for the insurance industry, and protect peoples' lives and livelihoods.

It will never be possible to predict extreme events with a hundred per cent accuracy. What's important is that we do all we can to assess how factors such as carbon-dioxide levels, melting ice sheets, and the thawing of the permafrost can impact hugely on the environment. The higher global temperatures rise, the greater the likelihood of extreme weather events. If we can understand and predict them better, we can help society be better prepared.

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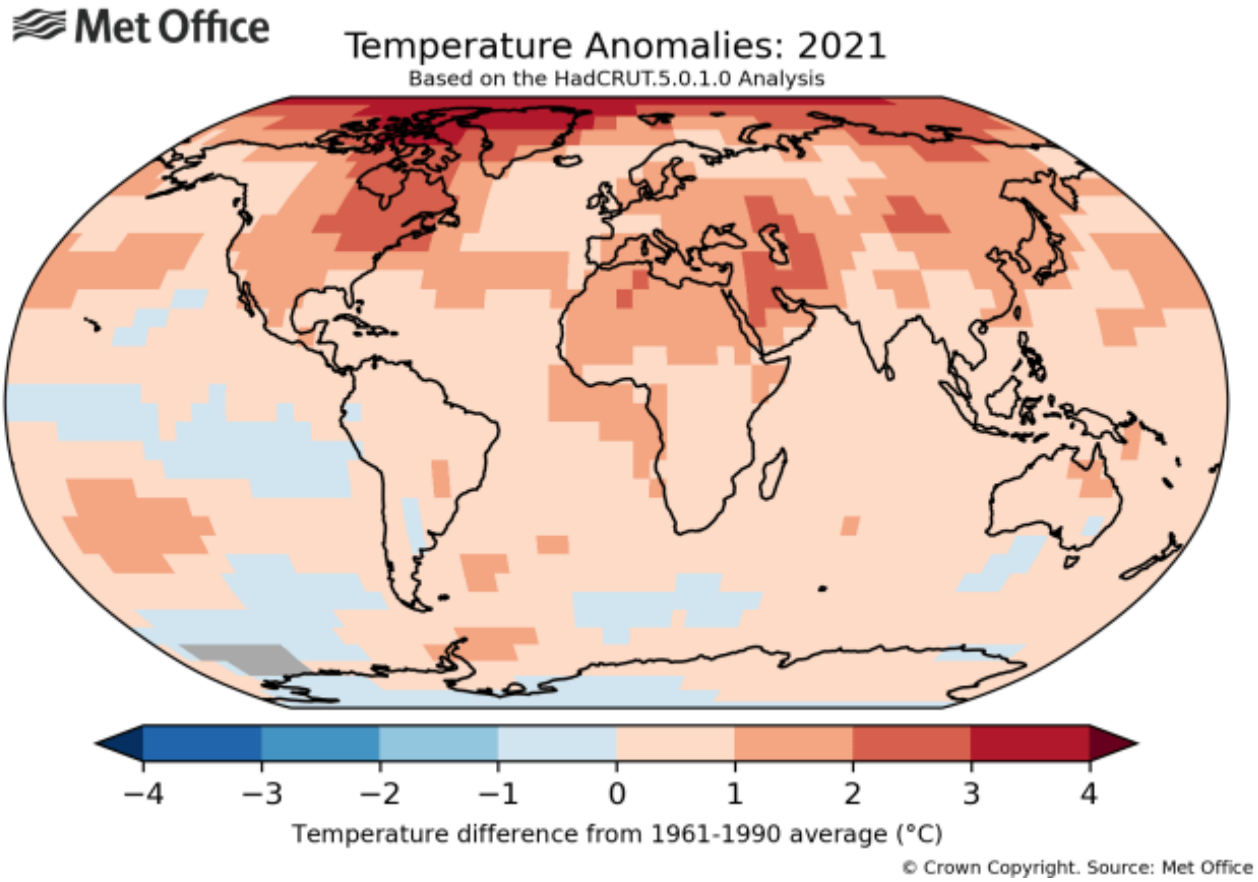
January 2022

Natural variation and the influence on global temperature

Description

2021 was another warm year globally – consistent with ongoing warming from greenhouse gases.

The global average surface temperature in 2021 was 0.76 ± 0.04 °C above the 1961-1990 average according to the Met Office and University of East Anglia's HadCRUT5 data set.



Regional differences in average temperature in 2021 are particularly pronounced with above average warming clearly evident in the Arctic.

This places 2021 as joint sixth warmest year since records began 172 years ago. Other climate monitoring centres rank 2021 from the fifth to the seventh warmest year in their records.

In the seven years from 2015, the planet's annual average surface temperature – as measured by the global network of weather stations, ships and ocean buoys – has been higher than in any year prior to 2015 in the recorded series beginning in 1850.

As the concentration of greenhouse gases in the atmosphere increases each year, why doesn't the annual global temperature increase every year too? The simple answer is that the planet's temperature

is subject to a certain element of natural variation, especially in the exchange of heat between the ocean and the atmosphere, especially in the tropical Pacific.

A cycle of variability known as the El Niño Southern Oscillation (ENSO) allows temperature to fluctuate between warm ‘El Niño’ years and cooler ‘La Niña’ years. When La Niña conditions prevail parts of the tropical Pacific are cooler than normal and this cooling has an impact on the overall average temperature of the earth – the opposite effect happens in an El Niño year.

Colin Morice is a Met Office scientist. Dr Morice said: “The variation in temperature in the tropical Pacific arising from ENSO events broadly coincides with the northern hemisphere winter. During 2021 the year was ‘book-ended’ by successive La Niña events which has had a modest effect on the average temperature, making 2021 cooler than recent extreme years.

The past seven years, which are the seven warmest years on record, encompassed an exceptionally strong El Niño event in late 2015/early 2016 and a “double dip” La Niña in 2020/21 and 2021/22. Dr Morice continued: “Variability in global temperature – particularly that associated with El Niño and La Niña events – mean we don’t expect each year in the global temperature record to be warmer than the last. However, over the full record, all 172 years, the long-term warming is clear.”

Taking measurements from weather stations and the temperature of the sea’s surface from ships has been a key part of meteorology for over 170 years. A fuller picture of the changing climate can be provided by considering other climate indicators alongside surface temperature.

Ocean heat content measures change in the energy in the global ocean. It has been estimated that over 90% of the excess heat trapped in the earth system by human-emitted greenhouse gases goes into the ocean. Dr Morice explained: “Measurements from different layers of the ocean are allowing scientists to record ocean heat content, and it is clear to see that a lot of the heat from global warming is being taken down into the deeper layers of the ocean. In contrast to surface temperature, ocean heat content rises more steadily as excess energy continues to accumulate in the climate system.” Recent results show that ocean heat content reached a new record high in 2021, as it did in 2020.

The effects of accumulating greenhouse gases and this excess of energy are seen across the earth system. Key climate indicators can be used to track some of these effects at the broadest scales.

Learn more about key climate indicators with our climate dashboards.

Date Created
January 2022

Elements of uncertainty

Description

Storm Arwen was identified days before it arrived on the UK's shores

Nothing is certain in life, goes the old saying, but death and taxes. To which should probably be added, "and the weather."

The United Kingdom is affected by changeable weather conditions because of its close proximity to the Atlantic. In addition, the country lies in the mid-latitudes, on the fringes of the Eurasian landmass with tropics to the south and the Arctic to the north. All these factors create dynamic tensions on our weather patterns.

The science of forecasting has improved greatly in recent years. Less-developed technology and meteorological science made it difficult to foresee the ferocity of the so-called Great Storm of 1987 (much of the damage was in fact caused by the then relatively unknown phenomena, a "Sting Jet"). However, by November 2021 Storm Arwen had been predicted, named and warnings disseminated days before the storm arrived. Thirty years ago, it was hard to provide an accurate forecast more than 24 hours in advance – now we can be accurate for up to a week.

Part of this improvement is not only driven by improvements to technology but also the collection of data. Over 200 *billion observations,* from all points of the globe, are now received daily at the Met

Office from satellites, radar, weather stations, ocean buoys, weather balloons and ship observations. The constant collection of data ensures the most up-to-date data is used by our weather models.

Having collated the data, we then do something called perturbing the data –making small adjustments to provide a variety of possible outcomes. Once we have 30 different outcomes, we compare these against one another to check for cluster patterns. For example, if 15 of the 30 data sets predict rain in Glasgow, we can state with reasonable confidence that there will be a 50% chance of rain.

Although forecasting the weather is now more accurate than ever before an element of uncertainty will always remain. However, we live in a world where uncertainty is unpopular. When you consider how the likes of aviation, travel, agriculture, leisure, the military, the insurance industry and so many other sectors are affected by the weather, eliminating uncertainty is not just desirable – it can be essential. The question is – how can we reduce the element of uncertainty?

A key part of meteorology is analysing how weather systems impact on each other. A good example of this uncertainty has been the recent unusual weather across the Northern Hemisphere. While Colorado suffered major bushfires due to drought and high winds, Washington DC and Japan experienced deep snow, and much of Europe was unusually warm with the UK recording its highest ever New Year's Day temperatures.

Paul Davies, Met Office Principal Fellow, explains how these seemingly disparate events are connected:

"These events arise because we are locked into a 'circumglobally teleconnection pattern'," says Davies. "This describes how an area of active tropical thunderstorms in the western Pacific interacts with the Asian Pacific jet, bringing colder weather into the heart of the US, and in turn increasing the strength of the Atlantic Jet Steam, driving associated weather fronts into the UK."

The more we understand the relationship between global drivers – including El Niño, La Niña, the Madden-Julian Oscillation **(**MJO) and phases of the sun – the more certain we can be about the future.

"A good analogy would be a football season," explains Paul Davies. "By looking at the results over the past few seasons, we can make fairly accurate predictions about the outcome of the title. But on a more granular level, there is still uncertainty. Even the Premier League holders can occasionally lose a match."

What we can do however is reduce the level of uncertainty by continuing to update the systems we use to collect data and study how systems interact. As technology continues to improve, and Artificial Intelligence makes it easier to run multiple possibilities for every situation, forecasts will continue to improve. The future for weather forecasting is bright. It's a shame we can't always say the same about the weather!

Date Created
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